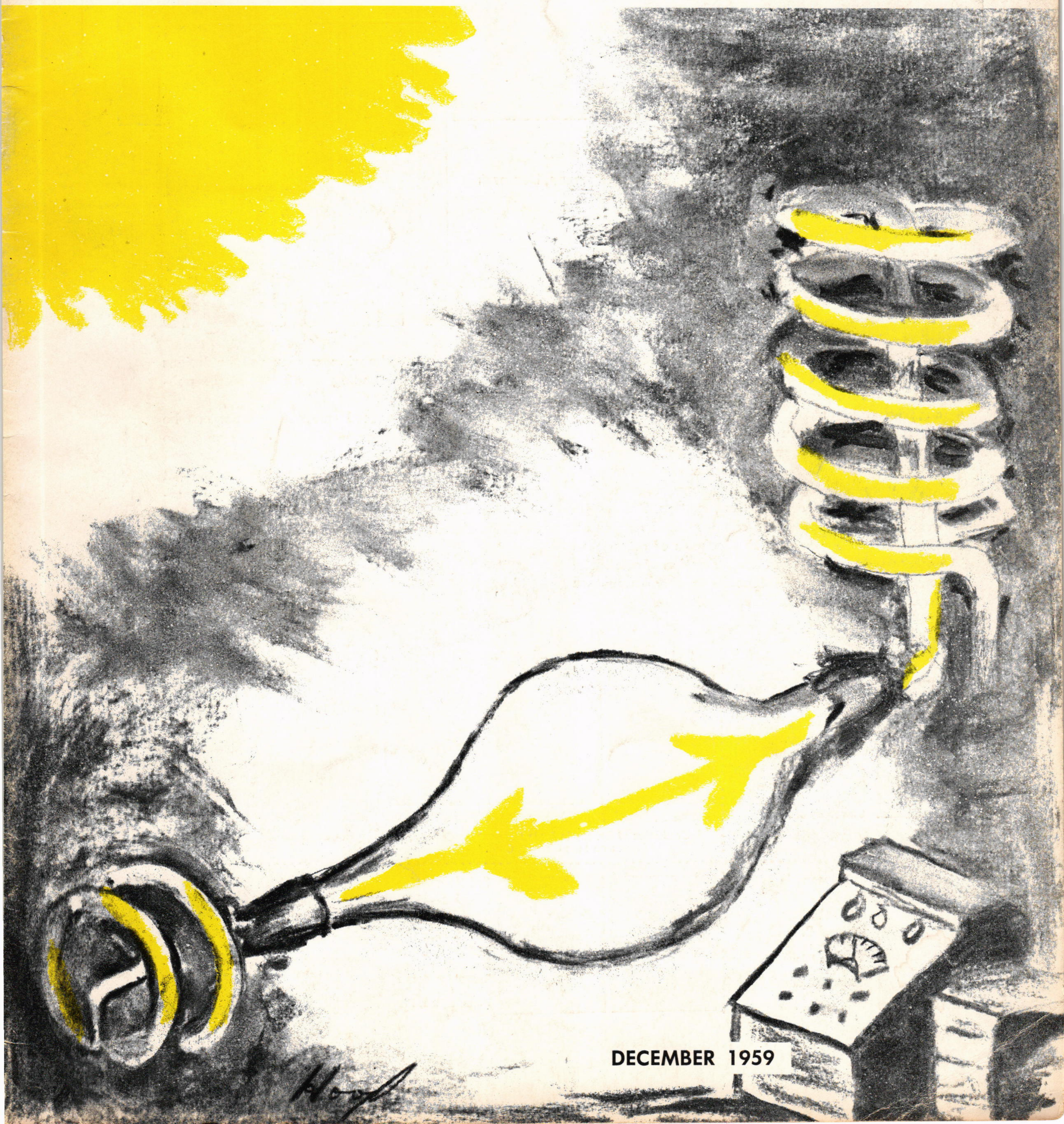
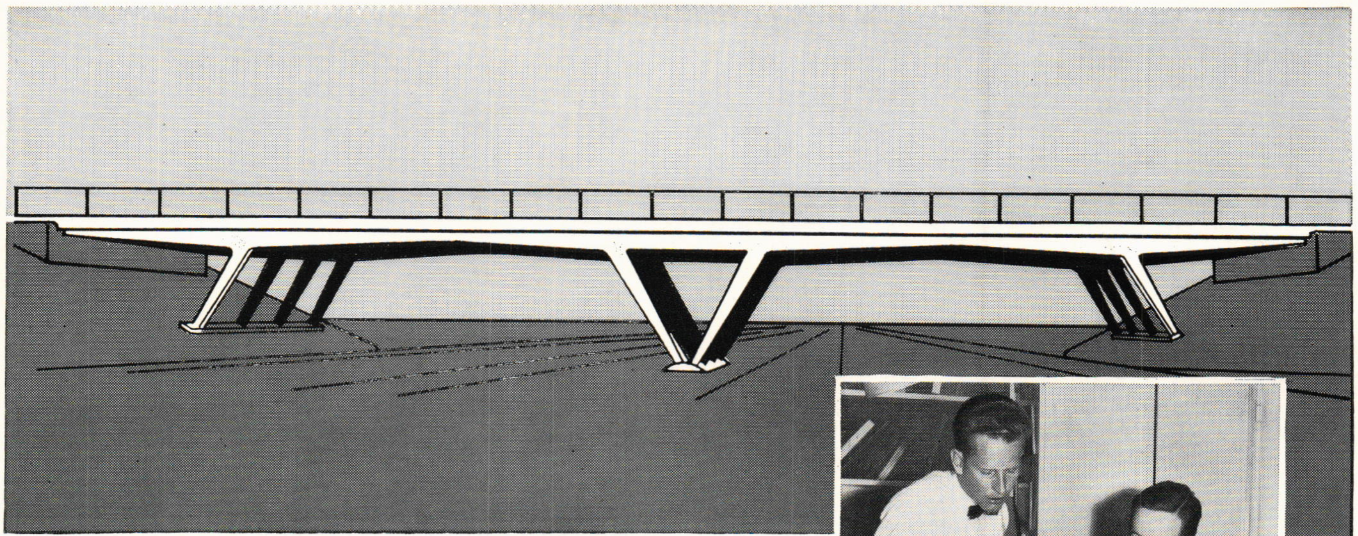
the Mecheleciv

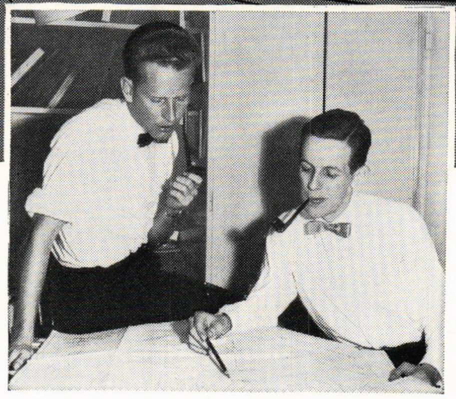
VOL. 18 a DECEMBER, 1959 NO. 3

THE GEORGE WASHINGTON UNIVERSITY ~ SCHOOL OF ENGINEERING



DECEMBER 1959





1st Award—$4,000—Student Class

Niels Jorgen Gimsing, Hattensens Alle 11, Copenhagen, Denmark
Technical University of Copenhagen (Graduate)
and
Hans Nyvold, Ulrikkenborg, Alle 62, Lyngby, Denmark
Technical University of Denmark (Graduate)

These students won $9,000 for bridge designs

American Bridge Division of United States Steel recently awarded $44,000 in world-wide competition for the best designs of small steel bridges. Professional engineers *and* college engineering students participated. Designs came in from 50 states and 40 foreign countries. From these entries, 15 winners were chosen, eight professional awards and seven student awards. They were selected under the supervision of the American Institute of Steel Construction. The judges were prominent consulting engineers and architects. They judged the designs on the basis of originality, economy, appearance and the utilization of steel. The bridges had to carry two-lane traffic over a four-lane interstate highway in accordance with AASHO standards. In addition to the winners, many of the designs entered were so outstanding that they will be published later.

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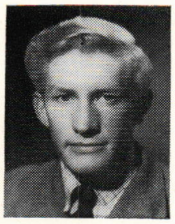


1st Honorable Mention—$2,000 Student Class James C. Costello

21 Leeson Park, Dublin, Ireland University College, Dublin, of the National University of Ireland

2nd Honorable Mention—$1,000—Student Class

James A. Wood

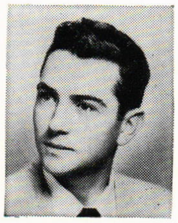
Jack A. Berridge

William O. Evers

Graduates of California State Polytechnic College, San Luis Obispo, Calif.

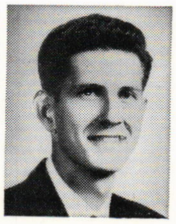
3rd Honorable Mention—$500 Student Class Troy R. Roberts

Route 5, Neosho, Missouri University of Missouri School of Mines and Metallurgy (Graduate)



3rd Honorable Mention—$500 Student Class Harland C. Zenk

Truman, Minnesota South Dakota State College (Graduate)



3rd Honorable Mention—$500 Student Class Albert C. Knoell & Rodger K. Gieseke

Drexel Institute of Tech. (Graduates) Philadelphia, Pa.

3rd Honorable Mention—$500 Student Class Joseph A. Yura

629 North 23rd St., Allentown, Penna. Duke University (Graduate)— Durham, N.C.

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The word *space* commonly represents the outer, airless regions of the universe. But there is quite another kind of "space" close at hand, a kind that will always challenge the genius of man.

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Our engineering efforts are directed toward a variety of VTOL and STOL aircraft configurations. Among earlier Sikorsky designs are some of the most versatile airborne vehicles now in existence; on our boards today are the vehicles that can prove to be tomorrow's most versatile means of transportation.

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the Mecheleciv

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ON THE COVER:

Our artist's conception of man's attempt to create an artificial sun in the laboratory. This month's feature article is about controlled thermonuclear reactions—the harnessing of the sun's source of energy.

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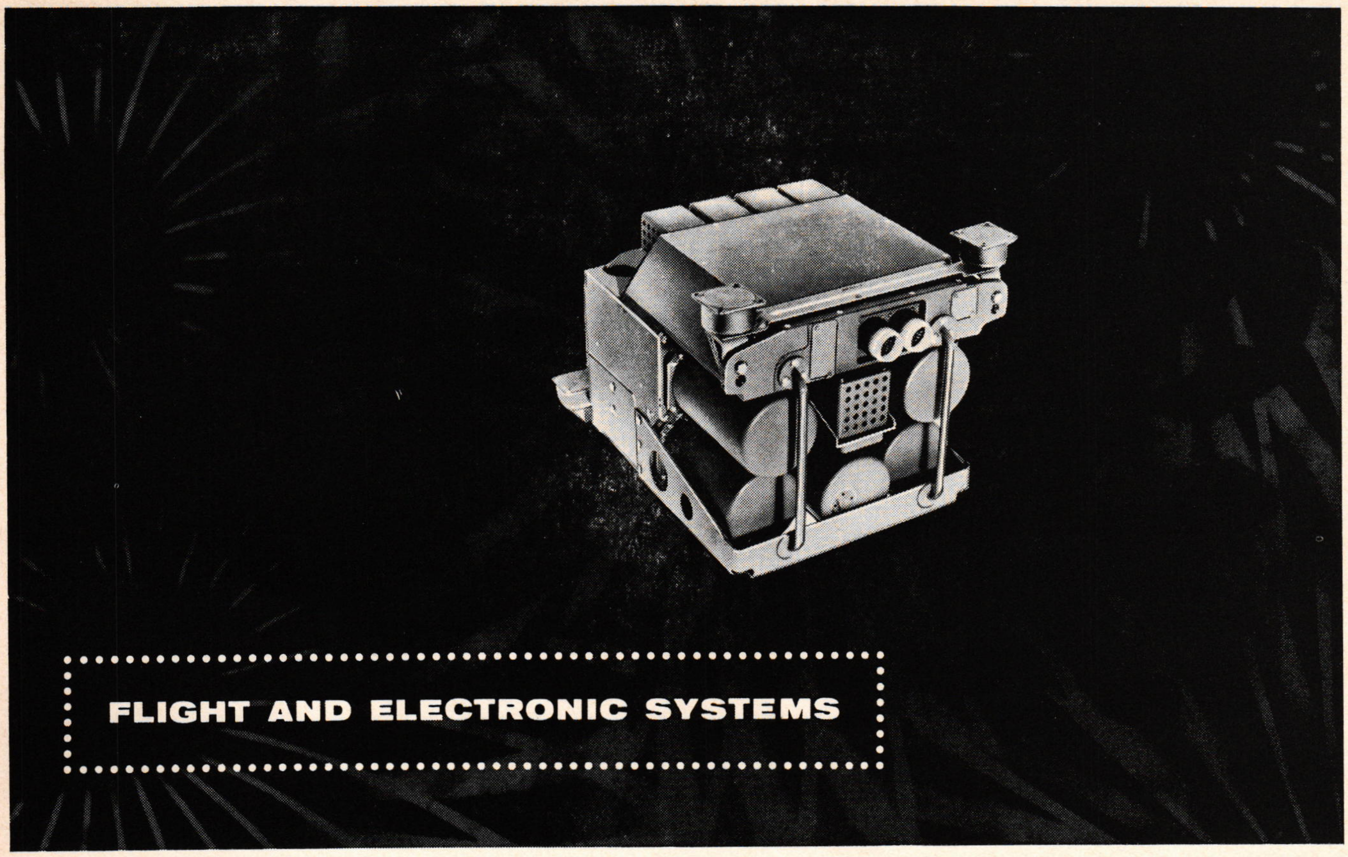
EXAMINATIONS

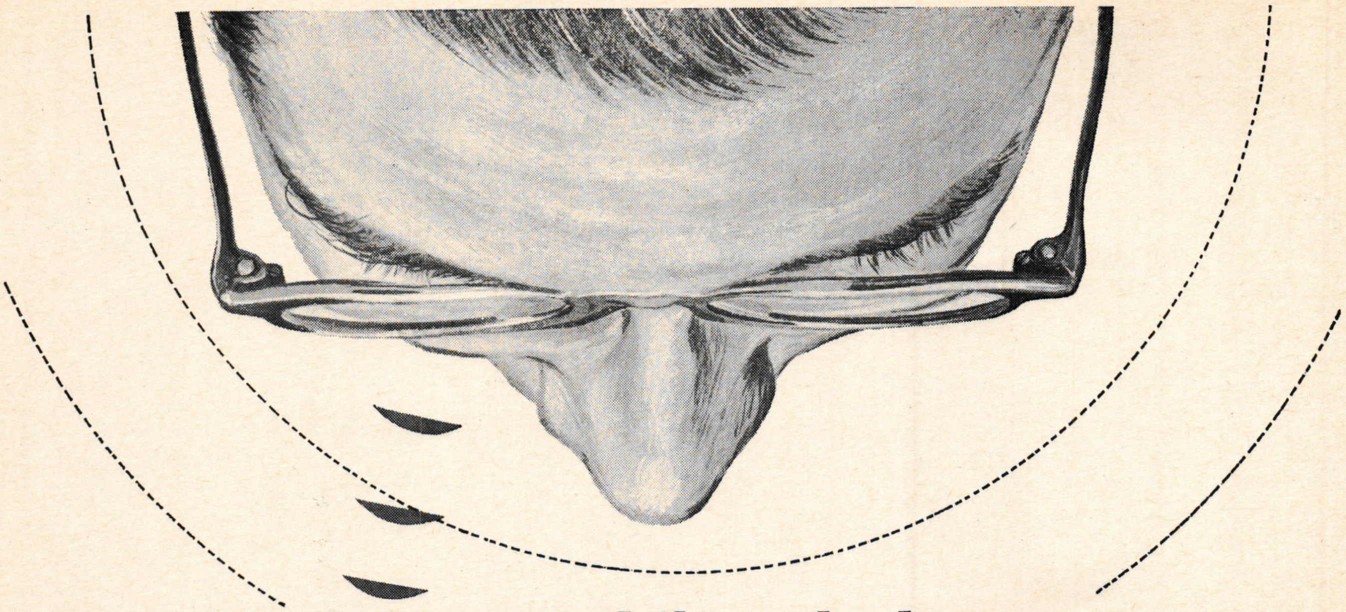
Every student in the School of Engineering has had the distressing experience of taking an examination in a subject for which he has thoroughly prepared himself, only to find that the examination is far removed from the course material, or involves some trick or gimmick, so that his preparation has been for nought. Such examinations are usually administered with the explanation that their purpose is to grade the student's ability to reason analytically; that the student will find that after graduation his work will not always consist of doing work in areas for which he has prepared himself.

Though we agree that a "cookbook" engineering approach is not adequate in today's world, we feel that examinations are not the proper medium with which to simultaneously acquaint and test students on radical new concepts which do not follow from previously covered material. If a student weathers the first two or three years of college he probably learns to take examinations of this type in his stride. He knows he can master the course material and begins to acquire some faith in his own abilities. He knows that a "10" on an examination of this type no more signifies that he is a poor student than that the recipient of a "100" is an excellent student.

The trouble lies in the effects such ill-prepared exams have on QPI's. And the importance of QPI's will be attested to by any student seeking employment.

What we are saying is that an examination should give a student a chance to show what he has learned of the material COVERED IN THE COURSE IN WHICH HE IS BEING EXAMINED. The professor should have worked the examination out in advance to see that there is a way of solving it and answering the questions asked with the information given. No one in the class need make a hundred, or a ninety, or even an eighty; but when the grades are in, neither should there be two distinct divisions—those who got an "A" and those who got an "F". Let's have the radical stuff and the tricks given in class or for homework, and let's have more thought in the preparation of examinations.


FLIGHT AND ELECTRONIC SYSTEMS



Look beyond the obvious . . .

. . . as you consider your first professional job. At Melpar, we believe that all young engineers and scientists should develop the habit of looking beyond the obvious.

First, what is the obvious? It's obvious that you're in demand. You don't have to worry about getting your material wants satisfied. And you don't have to worry about getting opportunities for professional growth. Since you are in demand, you can expect to get the things you want from any number of potential employers.

But, if you look beyond the obvious, you'll realize now that you're going to want something more than "want satisfaction" out of your career. You're going to want *pride*—pride in your personal, individual contribution.

At Melpar, where we are now working on 120 advanced defense and space exploration projects, we are interested *only* in young men who realize that pride is a reward that extends much beyond the obvious. Because Melpar is a proud Company. We're proud of our IMAGINEERING approach to the solution of electronic problems; we're proud of our uninterrupted growth and controlled expansion; we're proud of the communities that surround our laboratories and plants in Northern Virginia and Boston, and we're proud of our creation, design, and production of electronic products destined for universal application.

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Melpar's representative will visit your campus on February 5, 1960. Call your Placement Director to arrange a personal interview.

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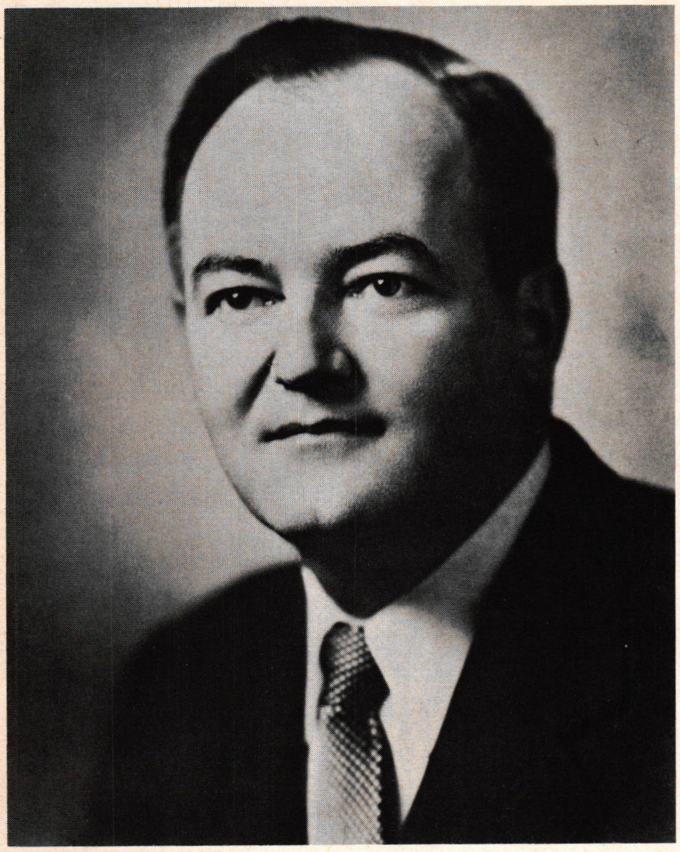
Engineers and Information

by SENATOR HUBERT H. HUMPHREY



Senator Hubert H. Humphrey, D., Minn.

The whole world is watching the United States to see whether free people can meet the challenge laid down by Nikita Khrushchev—that the Soviet Union intends to overtake and surpass us in production of the material goods which determine national strength and living standards.

Meeting this challenge head on—and meeting it while preserving the essential framework of a free society—may very largely determine the direction which will be taken by the newly-developing nations of the world. These new nations desperately need to raise their living standards, and are seeking patterns on which to base a rising economy. One of the great questions of the Twentieth Century is whether they will choose the Communist way or the Free World method of achieving their goal.

But we can not casually assume that we shall win the "competitive co-existence" ahead without making a more vigorous national effort. Already, there are more scientists and engineers in the Soviet Union than we have here in the United States. In 1957, the Soviet Union had almost 1.5 million scientific and technical workers. We had only 1.3 million. By 1961, Russian scientific and technical manpower will total about 2 million, about 20% more than the estimated 1.6 million in the United States. We are in danger of falling into second place if the Soviet Union can speed the growth of its economy through its superior numbers of trained manpower.

We must act swiftly, not only to increase the quantity and quality of American scientists and engineers, but also to enable them to work more effectively. There is a particular need to make world-wide scientific and technological information more broadly and readily available to our scientists and engineers.

The rapidly expanding research activities of government agencies, universities and business firms are pouring out a flood of new knowledge, but much of this valuable information is often wasted, because many people who need it simply can not find out what has been done already by someone else. In testimony before my Subcommittee in the Senate Government Operations Committee, one industrial research director estimated that the efficiency of chemical research in the United States is only 5 to 15 per

(Continued on Page 30)

Editor's Note:
Senator Humphrey wrote this article especially for Mecheleciv at the request of the Board of Editors.

CONTROLLED FUSION DEVICES

A survey of the major approaches used to utilize thermonuclear energy

by NICK KOPULOS, EE '60

Ever since theoretical research has shown that a large amount of energy is contained in the nuclei of matter, a primary concern of the human mind has been: how to utilize it?

The intensive and extensive investigations concerning the structural patterns of matter and its associated energy have been instigated for two main reasons: a) scientific curiosity, and b) economic considerations.

It is not necessary to enter into a discussion of scientific curiosity, because the challenge of the unknown has always intrigued the human mind. The economic considerations, however, are becoming progressively important, and they affect decisively the field of thermonuclear research.

No two appraisers of our energy resources agree how much longer it will be economically feasible to utilize conventional energy sources. However, the results of official studies indicate that the energy supplies are being depleted. According to some reports, today's principal energy sources, coal, oil, and gas will last for a long period of time; but more and more capital will have to be expended in order to utilize these sources. The energy production costs will be increasing along with the energy demands.

Of other sources of energy considered, solar energy is already being used for special purposes, but its intermittent nature does not make it very promising for large scale applications. Another source is the wind, and in some countries, it is used for small scale production of electrical energy.

All these attempts, however do not give much promise of fulfilling the increasing demands for more and cheaper energy. It is natural therefore, that our attention has been focussed on the nuclei of matter and the energy associated with them. But what is the nature of that energy?

NUCLEAR STRUCTURE AND FUSION

Matter is primarily composed of three basic building blocks: protons, electrons, and neutrons. Two of these blocks, the protons and the electrons, have positive and negative charges respectively. The neutrons do not have any charge. The mass of the protons and the neutrons is approximately 1800 times that of the electrons.

With this in mind we can visualize a hard, heavy core (nucleus) composed of protons and neutrons with the light electrons circling the core in all directions. The charge of the resulting structure (atom) is zero, because there is an equal number of protons and electrons in every atom. The atomic mass is approximately equal to the sum of the masses of the protons and neutrons composing the atom. The number of electrons determines the properties of the atom, and distinguishes the various chemical elements. For example, hydrogen, the lightest element, has only one proton and one electron. In addition there is one form of hydrogen with a nucleus consisting of one proton and one neutron; this is called deuterium and is abundant in ordinary water. Another form of hydrogen, with two neutrons in the nucleus, is called tritium, and is scarce. Deuterium and tritium are classified under the general name of *isotopes.*

The nuclei of the atoms are bound tightly, and the energy that keeps the protons and neutrons together is called binding energy. This energy is given by the Einstein equation

$$E = m c^2$$

where c is the velocity of light. The binding energy is not the same for all the elements, and it has been found that it is greater for the elements encountered in the middle section of the periodic table.

A neutron, because it has no charge, can penetrate into the nucleus of a heavy element, and cause it to split into two lighter nuclei and a number of neutrons. The mass of resultant particles, however, is less than the mass of the original nucleus. The difference in mass is converted into energy according to Einstein's equation. This process is called *fission* and it employs heavy elements and neutrons.

Another process by which energy is liberated is *fusion*. In this process two nuclei combine to form a new heavy nucleus. The mass of the resultant nucleus is less than the mass of the reacting nuclei, and the difference in mass—approximately 1/10% of the total mass—is again converted into energy. Because of the nature of the reaction light elements are used.

If a nucleus is very stable, a large amount of energy is required to break it apart, and, conversely, a large amount of energy is released when a strongly-bound nucleus is formed.

It has been found that a deuterium reaction produces He^4 nuclei or alpha particles, which have unusually high stability, and therefore release large amounts of energy when formed. In terms of reaction equations

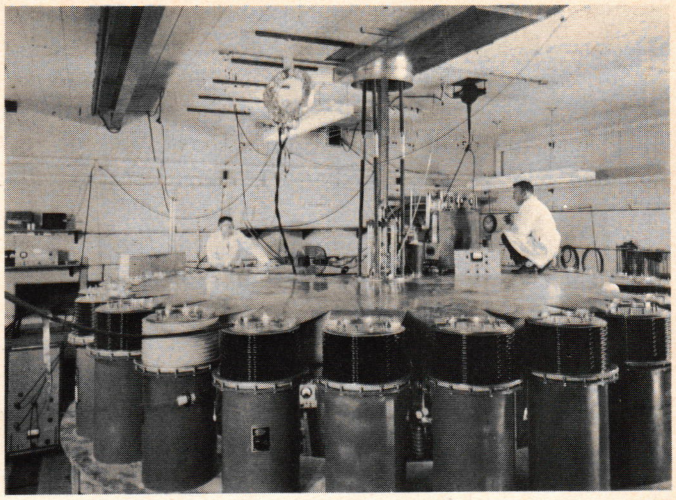
$$D + D \rightarrow He^3 + n + 3.25 \text{ mev}$$
$$D + D \rightarrow T + p + 4 \text{ mev}$$
$$D + T \rightarrow He^4 + n + 17.6 \text{ mev}$$
$$D + He^3 \rightarrow He^4 + p + 18.3 \text{ mev}$$

The tritium-deuterium reaction is the most probable one and yields a rather large amount of energy. Since tritium by itself is very scarce and radioactive, deuterium alone can be used as fuel which will subsequently produce tritium.

According to Coulomb's Law, a repulsion force exists between the positively charged nuclei; therefore, for a reaction to occur, this repulsion force must be overcome.

At this point it is necessary to define a few terms that will be used frequently hereafter. *Plasma* is the fully ionized gas in which the electrons have been dissociated from the nuclei. *Reaction cross section* is a measure of the probability of a reaction.

To overcome the electrostatic repulsion of the nuclei the initial energy supplied to the deuterons must be of the order of 0.1 mev. The useful energy output is the difference between the energy released by the reaction and the supplied energy. Since the energy liberated in a D-D reaction is approximately 18 mev, a large amount of usable energy will be available. For comparison purposes, the deuterium contained in one gallon of water can provide energy equivalent to that of 300 gallons of gasoline.



A view of the main capacitor bank of the Columbus II. The thermonucelar reaction takes place in the vertical tube at center.

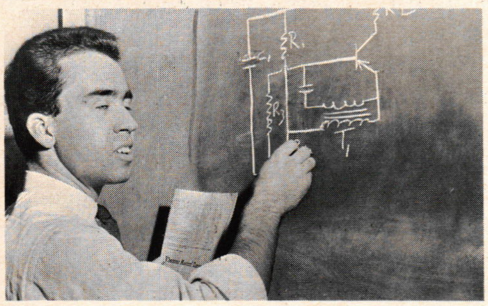
Photo by Los Alamos Scientific Laboratory

The speed of the particles necessary to break the energy barrier is some hundreds of miles per second. To achieve fusion the particles must be held together long enough to react and form a new nucleus. One of the simplest solutions would be to shoot high energy deuterons on to a solid target causing fusion of the colliding particles. However, most of the initial energy of the nuclei would be lost due to the scattering collisions in the path of the particle. The remaining kinetic energy would cause slight heating of the target, and the total output energy would be less than the losses associated with converting the heat to electricity.

By increasing the temperature to approximately 100 million degrees K, the gas becomes fully ionized, forming a plasma of electrons and nuclei, and the probability of fusion increases.

Although fission was discovered later than fusion (fusion-1934, fission-1938) the first chain reacting pile was built in a comparatively short period of time (1942), while a successful fusion device has not yet been developed. The problems that are being encountered today in the field of thermonuclear research, and the rate of their solution, may not make possible the utilization of thermonuclear energy for the next 20-30 years. Of course, this is an assumption based on the present stage of research, and a new discovery tomorrow does not exclude the possibility of having thermonuclear energy sooner.

The main reason for the faster development of fission



Nick Kopulos, a senior in Electrical Engineering, was born in Atalanti, Greece, 22 years ago. After graduation from Atalanti High School, he came to the U. S., entering GW in the spring semester 1956. Nick is a member of the AIEE-IRE, and the Board of Editors of Mecheleciv, and works 20 hours per week at DOFL, but still finds time to take a full load at school. Nick's hobbies are sailing, swimming and the pursuit of women.

devices is the availability of the services of the neutron. The neutron, having zero charge, can penetrate the nucleus of an atom easily, because it is not affected by the nuclear charges. In the fusion process, however, neutrons do not enter into the picture except as products, and the two colliding particles are similarly charged thus repelling each other.

Due to the difficulties encountered, one might ask the question: Why are we so persistent in our fusion research, since we already have utilized fission?

First, the safety hazards associated with fusion are much smaller than those associated with fission. The products of a fission reactor are long-lived radioactive wastes requiring proper shielding and disposal. In a fusion device there would be no radioactive products left, although the device itself would be radioactive. Second, in an atomic plant the fission reactor actually takes the place of a coal furnace in a conventional power plant, with the rest of the system, turbogenerators, etc., being essentially the same; while fusion devices would be converting heat directly into electricity without the use of turbines and generators. Third, conditions existing only in the stars would be created in the laboratory for further studies of the universe.

MAGNETIC FORCES AND PLASMA CONTAINMENT

At the temperatures required for nuclear fusion, a material container for the plasma cannot be used, since the highest melting point of any known solid is on the order of 3000 degrees K. At thermonuclear temperatures forces such as magnetic forces acting at a distance are used to contain the plasma.

A charged particle moving in a uniform magnetic field in a direction perpendicular to the direction of the field is subjected to a constant force which causes the particle to follow a circular path. (Figure 1).

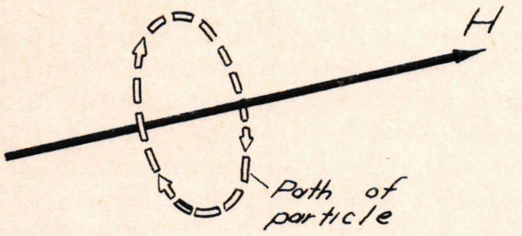
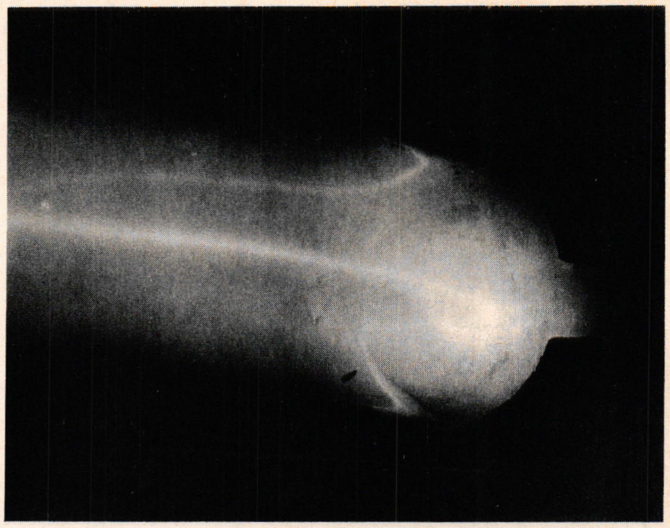


Figure 1

If a potential gradient is applied along the direction of the magnetic field, the particles will be subjected to two forces simultaneously: one central force due to the magnetic field, and one axial force due to the electric field; as a result the motion of the particle will be a helical path.

The plasma containing nuclei and electrons in an ionized state has an extremely high electrical conductivity, and only a small number of particles diffuse through the magnetic walls. If the conductivity of the plasma were infinite, no diffusion would occur. As temperature increases the conductivity also increases, and at 100 million degrees K it is approximately 100 times that of copper. At these temperatures the diffusion is slow enough for the plasma to achieve the required containment time which is in the order of seconds. If the magnetic field strength is increased, the nucleons and electrons are subjected to greater forces, and the diffusion rate is decreased. The rate at which the particles diffuse is inversely proportional to the square of the magnetic field strength.



Photograph illustrating pinch effect in a Perhapsatron. The horizontal beam is the compressed gas in the tube, heated to a high temperature by the compression.

Photo by Los Alamos Scientific Laboratory

The plasma, behaving like any other gas, exerts outward pressure which is proportional to the temperature and the density. This pressure is given by

$$P_p = nkT$$

where n is the plasma density, k is a constant known as Boltzmann's constant, and T is the plasma temperature. To achieve magnetic containment, this pressure must be less than or equal to the pressure exerted by the magnetic field. The force due to the magnetic field is known as Maxwell's magnetic stress tensor and is given by

$$P = B^2/8\pi$$

where B is the magnetic field strength.

At a temperature of 100 million degrees and $n = 2 \times 10^{15}$ the pressure is 27 atmospheres. The magnetic field strength necessary to contain the plasma under these conditions must be greater than or equal to 26,000 gauss. Thus the problem of creating a field of such strength arises.

Two basic approaches to the problem of plasma containment are being investigated at the present time. In one phase of the research, the plasma current itself is used to create a magnetic field, which in turn will exert pressure on the plasma. Because of the high values of the plasma current the magnetic field can become strong enough to contain the plasma. This phenomenon is known as *pinch effect.* The second major approach is the creation of mag-

netic fields from external currents.

Pinch effect. When a potential difference is applied between the two ends of the gas container, an electric current is started by the motion of the ions in the plasma.

Initially, without a potential difference and therefore without any field, the ionized gas would be uniformly distributed throughout the container. As soon as a potential difference appears between the ends of the container, an electric current starts. This current in turn gives rise to a magnetic field whose lines of force are exerting a central pressure on the plasma. (Figure 2).

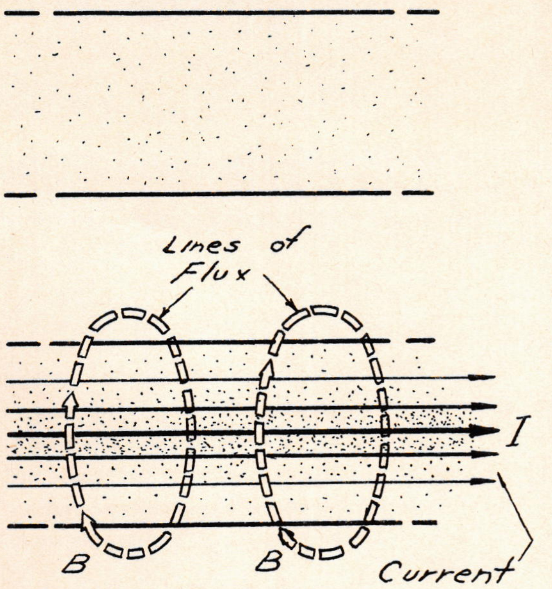


Figure 2—Plasma distribution without and with applied potential difference.

The radial pressure exerted by the magnetic flux lines causes the particles to concentrate in the center of the cylindrical container forming a stream of electrons and protons at high densities. In this manner temperatures and pressures are obtained at which thermonuclear reactions can take place.

From the self-containment effect, one may think that as the current density increases, the magnetic pressure also increases causing unlimited plasma compression. This, however, is not the case, because the problem of instability arises.

Small irregularities in the region in which the magnetic field acts will cause magnetic field distortions which will tend to further amplify the irregularities. These perturbations grow rapidly, and the velocity of growth is limited only by the sound velocity of plasma, which is very high. Due to this instability the particles escape from the containing field, and hit the walls of the metal container thereby losing much of their energy. The containment time is much shorter (on the order of microseconds) than the time required to achieve thermonuclear reaction (order of seconds).

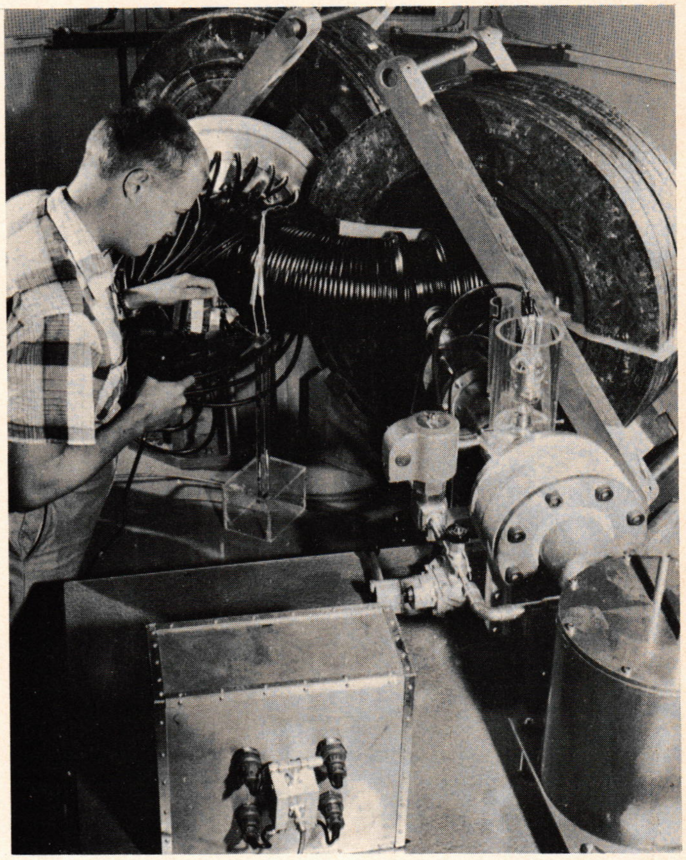
Various attempts have been made to eliminate instability. Such attempts consist of making the walls of the container conductive so that the magnetic field can not penetrate them for a short period of time. When a kink develops in one part of the field, the magnetic lines are compressed in one side of the tube because they cannot penetrate the conducting walls. The increased flux density pushes the plasma back toward the center of the tube. In addition to the conducting walls, a longitudinal stabilizing field in the direction of the current is used. It is hoped that these two stabilizing fields will provide high enough plasma temperatures and pressures to start and sustain a thermonuclear reaction. At the present time experiments are being conducted using this method of stabilization, but definite results have not been obtained.

One of the major problems of the stabilized pinch is that the mixing of the axial stabilizing field with the magnetic field of the pinch causes pinch breakdown. Also the energy invested in creating the additional axial magnetic field must be very high to make such a device useful to operate.

Devices utilizing the pinch effect belong to two categories: *linear pinch,* and *toroidal pinch.*

The linear pinch devices consist of a straight tube in which high voltage discharges are produced between electrodes in the two ends of the tube. These discharges cause the high voltage gradients needed to produce large plasma currents.

In one of the first linear pinch devices, Columbus I, developed at Los Alamos, the tube is 100 cm. long. A potential difference of 100,000 volts in this device causes a voltage gradient of 1000 volts/cm., which is high enough to obtain thermonuclear temperatures. During the opera-



The Perhapsatron S-4, a toroidal pinch device, was one of the first attempts to control thermonuclear reactions.

Photo by Los Alamos Scientific Laboratory

tion of this device neutrons were detected indicating that fusion had taken place. These neutrons, however, were not thermonuclear neutrons, but they were caused by collisions due to partial heating of the plasma. For sustained reaction the whole plasma must be heated to thermonuclear temperatures. The uniform heating of the plasma is attempted in a new device called Columbus II, in which the gas is preheated and fully ionized before the voltage gradient is applied.

The toroidal pinch devices employ a toroidal tube containing the gas. The Perhapsatron S-4, one of the first devices developed at Los Alamos, has a doughnut-shaped discharge chamber. The voltage gradient is provided from a capacitor bank discharged through a coil coupled to the toroid. From this discharge a current is induced in the contained plasma.

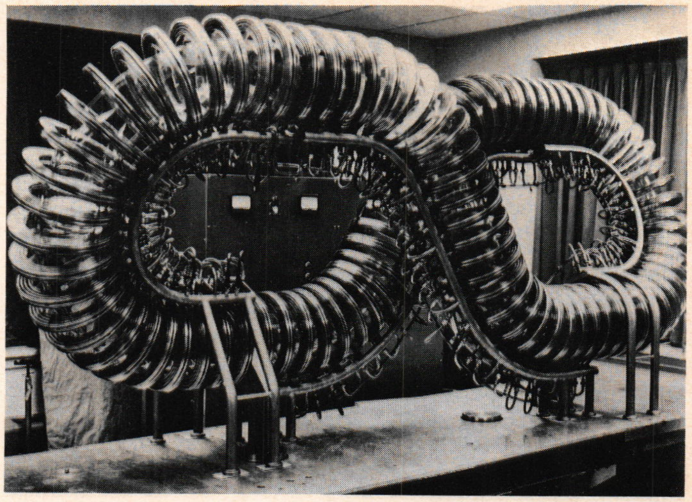
Perhaps the most widely known toroidal pinch device is the British ZETA which a few years ago made the headlines as having achieved a sustained reaction. The ZETA consists of a toroidal tube of metallic walls filled with gas at a pressure of 10^{-4} mm Hg. This tube acts as the one turn secondary of a large transformer. The primary current is supplied from a capacitor bank storing half a million joules of energy. Initially, it was thought that the neutrons yielded were not instability neutrons, but products of nuclear reaction. This claim was later disproved. Even if the goal was not achieved, the confinement time in ZETA was reduced to milliseconds in comparison to the microseconds of other devices.

In the other major category of nuclear devices—that of externally produced magnetic fields—various approaches have been made by independent research groups.

One group at Princeton University under Professor Spitzer is engaged in developing a thermonuclear device called "Stellarator." This machine consists of an endless tube to which the magnetic field is externally applied. A toroidal tube cannot be used in this application because the external current windings produce a non-homogeneous magnetic field inside the tube causing separation of the positive and negative charges. This charge separation gives rise to an electric field inside the tube, which tends to neutralize the magnetic field and cause the particles to lose their energy by striking the container walls. This problem is eliminated by building a container in the form of a figure **8**. In this configuration the magnetic lines of force are no longer degenerate (not closing on themselves), and the particle inward-outward drift is compensated by the different curvatures of the tube.

The addition of special helical current windings has simplified the Stellarator into a toroidal-shaped device. The helical current windings cause the magnetic lines of force to oscillate and gradually rotate as they go around the torus. The initial heating of the gas is accomplished in the same manner as the pinch effect. The plasma is heated to thermonuclear temperatures by using magnetic pumping—increasing and decreasing the magnetic field strength.

At the present time work is being done on the Stellarator—C model which when finished is expected to produce useful output power.



Stellerator thermonuclear device developed at Princeton University. The "figure-eight" shape permits a strong magnetic field to serve as a "magnetic bottle" for the plasma.

Photo by Princeton University

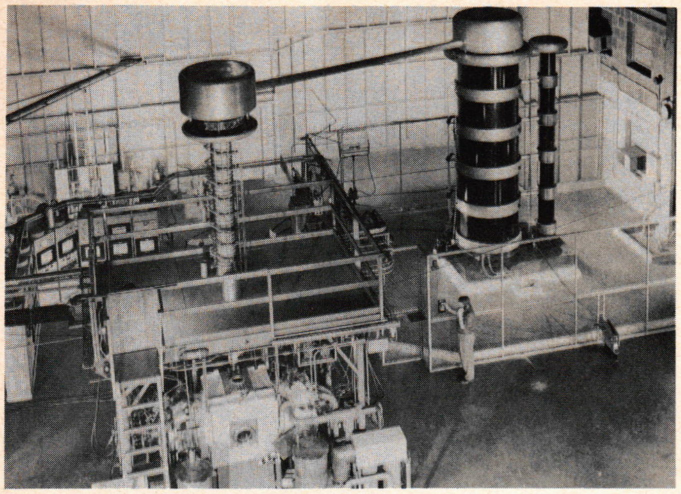
The *magnetic mirror* concept utilizes a straight section of a tube with the magnetic field applied in the axial direction. Current carrying conductors are wound around the tube, and the number of turns at the center of the tube is smaller than at the ends. The field created by the current in the conductor is weak in the center and strong at the two ends.

As the particles moving in a helical path leave the uniform weak field at the center of the tube and reach the non-uniform field at the ends, they are reflected back into the weaker field, where they are contained. If the particles have high energy in the axial direction, the magnetic mirror at the ends of the tube will not be able to repel them, and they will escape. For effective confinement, the particles must be injected into the field with low energy in the axial direction and high energy in the transverse direction. The energy in the axial direction, however, increases at the expense of the transverse component, due to the collisions of the particles.

In the mirror machine it is hoped that fusion will occur before the particles escape from the field.

One type of mirror machine, the Pyrotron (developed at the University of California Radiation Lab), uses adiabatic compression to give the ions energies needed for thermonuclear fusion. The particles are injected into the container in the transverse direction when the field strength is low. When the field is increased rapidly the transverse energy of the particles is also increased by the same factor as the field. In this manner thermonuclear temperatures can be attained.

Further developments in the mirror concept include the DCX machine built at Oak Ridge and using an efficient injection principle. The deuterium molecular ions are preheated by a linear accelerator, and are shot through a strong DC arc in the center of the container. Passing through the arc the molecular ions are converted into deuterons and uncharged atoms. The deuterons, having a smaller radius



DCX machine, at Oak Ridge, uses the mirror concept (see text) for plasma containment. Vertical tube at upper center is deuterium accelerator, and high voltage generator is at right.

Photo by Oak Ridge National Laboratory

of curvature than the molecular ions, are trapped in the field, while the atoms and the molecular ions escape.

Another approach to the problem of fusion is the *rotating plasma* concept. In this type of machine the application of radial electric and transverse magnetic fields causes the plasma particles to precess rapidly about the central axis.

A new approach to the problem of thermonuclear fusion uses a cylindrical sheet of high energy electrons (E-layer) for plasma confinement and heating to thermonuclear temperatures. This device, the Astron, was proposed by N. Christofilos and is now being built at UCRL.

An axial magnetic field is produced by coils, wound on an evacuated cylinder. If high energy electrons are injected into the cylinder by some means, they form a current layer about the central axis of the cylinder. This current layer produces its own magnetic field which interacts with the initial field. From this interaction lines of force closing inside the cylinder are produced having axial symmetry with no field components in the azimuthal direction. These closed magnetic lines provide an effective means of plasma containment. When a mixture of deuterium-tritium is injected into the chamber, the gas becomes fully ionized forming a plasma of electrons and protons. The energy of the plasma increases due to the collisions with the electrons of the E-layer, and it reaches the point at which nuclear reactions can take place. In this process the E-layer is continuously losing electrons, and in order to maintain the E-layer, electrons must be continuously injected from outside.

This device is in the experimental stage, but preliminary studies have shown that a power reactor based on the Astron concept can be built, and it will be able to compete with conventional power sources. However, as in the previous machines the Astron group faces problems whose solutions do not appear to be imminent.

Even if a device is developed which will be able to initiate and sustain a thermonuclear reaction, this by no means will bring thermonuclear energy into our houses. One of the problems that the engineers will have to solve will be how to convert the energy released by the thermonuclear reaction into electricity. So far, the energy required to operate the nuclear fusion machines is extremely higher than the energy obtained from the nuclear fusion. In a practical nuclear fusion machine, the energy required for the operation must be supplied from the energy released from the reaction, and the remaining energy must be sufficient to satisfy the consumers' demands at a cost less than that of the conventional sources.

Besides the economic implications of nuclear energy production, the engineer and scientist have an additional reason for pursuing nuclear research: the challenge of the unknown, and the mastery of nature.

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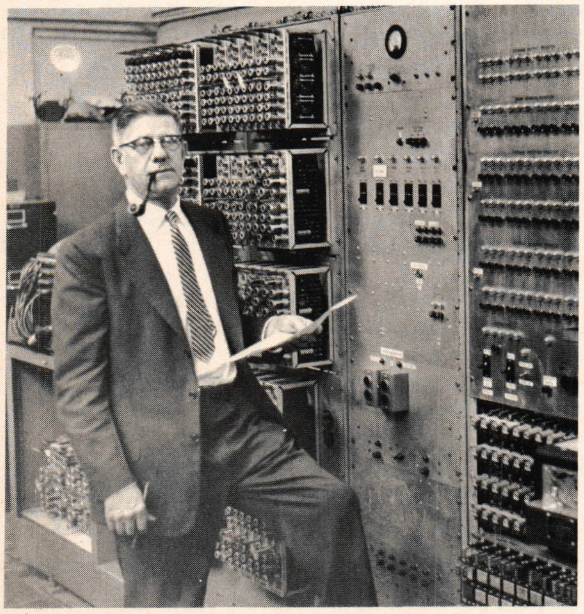
Faculty Page

THE DEANS SPEAK



Dean Martin A. Mason

Assistant Dean Carl H. Walther

All answers to the questions in this interview are strictly the opinion of Dean Mason and in no way are to be construed as statements of school policy.

Q. Do you think the engineering student cares what the rest of the University is doing?

A. Yes they do, but their concern is low on the list of things which are of importance to engineering students.

Q. Do you believe the HATCHET gives adequate coverage of engineering school functions?

A. No, in fact the HATCHET does not give adequate coverage to life in the University. The paper does not represent the thinking or the attitudes of the student body in the University, although I believe the paper does attempt to do an adequate job of reporting with the resources available to it. In my opinion the HATCHET is not a vital force in the student life of the University.

Q. What is your opinion about holding more social functions involving the whole engineering school?

A. I think the student body gets what it demands and what it needs. The place of social activities in the life

All answers to the questions in this interview are strictly the opinion of Dean Walther and in no way are to be construed as statement of school policy.

Q. Dean Walther, are there any new curriculum changes contemplated for next year?

A. The ME, EE and BS departments are holding the line with no changes, but there are a few in the CE Department. Surveying will be moved to the third year so the first two years in CE will be the same as they are in the other curricula. There are relatively minor changes in requirements in the last two years, representing shifts in emphasis or developments of faculty capabilities.

Q. How does our curriculum compare to that of other schools?

A. It is one of the most modern and analytical in the country.

Q. Why is the engineering curriculum becoming more technical?

A. There is a revolutionary change going on in the profession in the concept of engineering performance. The engineer is being employed in truly professional work and is getting away from routine jobs. This role calls

MASON

of a student of our School of Engineering is quite different from what it would be in a different university. In this sophisticated area additional social activities without strong support are not only unwise but a fantasy. The students themselves should make the decisions on this question. In my opinion not having them means they don't want them.

Q. Do you believe the engineering student has adequate time to engage in extracurricular activities?

A. They have more than enough time; most students do not utilize their time for the most important things. A student has plenty of time to devote to what he wants to do, but there has to be a desire.

Q. Do you think "MECHELECIV" could do more to help inform the student about his school?

A. I believe the magazine has made a good start in the right direction, but more might be done. I think the student needs to decide if MECHELECIV is going to be a driving force in the school.

Q. What do you think could be done to help improve the "MECHELECIV?"

A. I believe the magazine will be important to the student when he finds things in it which interest him. The magazine should not be a pure technical publication. The publication of technical papers by students is not of great importance except to the author. The magazine should reflect the interests of the student body.

Q. Why don't more students take an active interest in their student chapter societies?

A. There are several reasons: 1. Lack of imagination in the programs to appeal to students at the present moment. 2. Students are more concerned with preparing to earn a living than with professionalism. 3. The chapter activities are not vital, alive, and compelling. This same problem exists with societies outside the University. Every professional society has this same problem.

Q. With the great emphasis on QPI and the differences in instructors grading systems, have you any opinion on departmental exams?

A. Common exams are already frequently given. At the present time there is far too much attention given to grades. We attempt to shift instructors in courses which all students have to take, in this way each student gets a sampling of the different instructors. For this reason departmental exams have much less importance and value. One exam which all students have to take is the Graduate Record Exam. GWU students rank about 20% higher than other Universities in this examination. I am opposed to departmental exams myself. I think the instructor is better able to measure the competitive level of the students in his class.

Q. Why is the engineering school curriculum becoming more technical?

A. The school is trying to keep up to date with the profession. The curriculum is a little bit behind the profession and a little bit ahead of what the student thinks he can do. The lag between the discovery of a new engineering idea and its application is now often less than five years, while fifteen or twenty years ago the lag was from twenty to fifty years. The University is attempting to prepare the student for a productive career; we are one of the few schools in a position to keep up with the profession.

Q. How does GWU Engineering School compare with other Engineering Schools?

A. We really don't know how to rate schools. Also we are not concerned with rating this school with others but with giving the student the best professional education we can.

Q. How does our curriculum rate with that of other schools?

A. Our requirements for achievement are somewhat more rigorous than those of other schools in general. The philosophy of education here is greatly different than in a publicly supported school. Our objective is to educate top quality engineers. Students who find it hard to achieve top quality are likely to find GWU a hard school.

Q. How do GWU graduates rate with the graduates from other schools?

A. We have no real information on this question. It is hard to rate comparatively although many people have concerned themselves with this idea. One way of rating graduates is by the Graduate Record Exam which is required by about 40 out of the 160 accredited engineering schools. Another is by the number of graduates who go on to take graduate courses and the number of these individuals who complete a graduate degree. Our students have done very well in both ways.

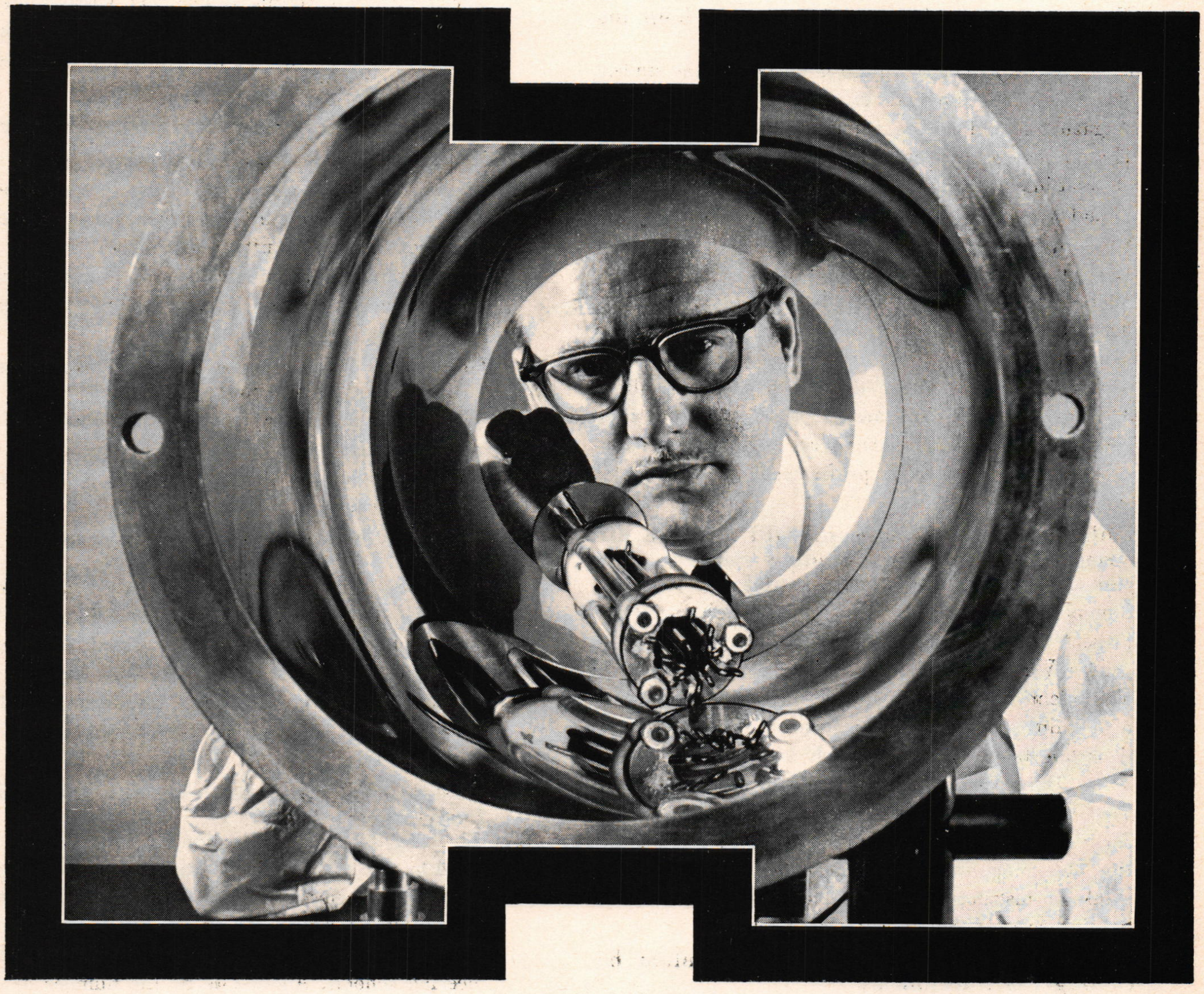
WALTHER

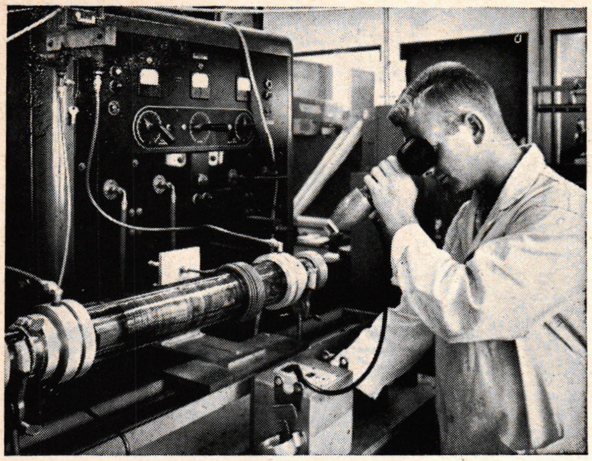
for a better understanding of the basic sciences and engineering sciences. The engineer must also have greater analytical skill and proficiency in mathematics. It is more difficult for the engineer to study these basic ideas after graduation than it is in school, with instructors help. We are trying to educate the engineer to take his place in the profession five to fifteen years hence. We are hampered by having to stick to a four year curriculum and therefore must throw away the less essential courses in engineering that can be taught to the engineer on the job. We have chosen fundamentals over techniques. Principles are enduring.

Q. Will some interdepartmental courses be dropped so that room can be made for departmental electives?

A. This is very unlikely because we feel that the fundamental courses in basic and engineering sciences are essential. Maybe some of the less important courses in one's own department may be subsituted. As far as substituting a technical elective for a humanity we are very reluctant to do this. If a student is really interested in a course beyond the minimum curriculum there is no law which says he can not graduate with more than the required 140 hours.

Checking Einstein with





Purity Plus—*Hughes Products Division engineer checks semiconductor materials to insure purity.*

Exit cones *capable of withstanding temperatures of 6000° F. represent one example of advanced engineering being performed by the Hughes Plastics Laboratory.*

an atomic clock in orbit

To test Einstein's general theory of relativity, scientists at the Hughes research laboratories are developing a thirty pound atomic maser clock *(see photo at left)* under contract to the National Aeronautics and Space Administration. Orbiting in a satellite, a maser clock would be compared with another on the ground to check Einstein's proposition that time flows faster as gravitational pull decreases.

Working from the new research center in Malibu, California, Hughes engineers will develop a MASER (Microwave Amplification through Stimulated Emission of Radiation) clock so accurate that it will neither gain nor lose a single second in 1000 years. This clock, one of three types contracted for by NASA, will measure time directly from the vibrations of the atoms in ammonia molecules.

Before launching, an atomic clock will be synchronized with another on the ground. Each clock would generate a highly stable current with a frequency of billions of cycles per second. Electronic circuitry would reduce the rapid oscillations to a slower rate in order to make precise laboratory measurements. The time "ticks" from the orbiting clock would then be transmitted by radio to compare with the time of the clock on earth. By measuring the difference, scientists will be able to check Einstein's theories.

In other engineering activities at Hughes, research and development work is being performed on such projects as advanced airborne systems, advanced data handling and display systems, global and spatial communications systems, nuclear electronics, advanced radar systems, infrared devices, ballistic missile systems...just to name a few.

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STANDARDS ENGINEERING

by **ROGER F. BELL**
Standards Engineer, Litton Industries, Maryland Division

In modern industry technical standards are a vital means of freeing engineers for creative work.

The enormous variety of products, techniques and methods resulting from the technological progress since World War II has tended to increase seriously the time remaining for creative work. Young engineers, anxious to apply their hard-won education, often feel particularly discouraged by the amount of time spent searching through the advertising literature. To solve this and related problems, a body of technical standards has been developed.

Now the concept of standardization is not new; standard units of measure, standards of quality and of conduct have been a corollary, and perhaps a criteria of civilization. The expansion and development of the concept to meet vital modern needs *is* new. Indeed, a whole new professional field has evolved: standards engineering offers great challenges to both specialists and generalists with engineering and scientific backgrounds.

Technical or industrial standards can be grouped into two general categories; those which define the general requirements for a process or course of action and those which set specific criteria for judging the acceptability of physical items. The military agencies have dubbed the former "Military Standards" and the latter "Military Specifications," while most industry associations lump both kinds under the title "standards."

The purpose of these documents is primarily to reduce the variety of similar processes or items. Certain representative and useful choices become the standards and the remainder are left for unique situations. If the choices have been wisely made, the standards will gradually supplant the seldom-used options, and savings will result for governments, industries, plants *and* engineers.

By reducing unnecessary or undersirable variety the customer gets what he bargains for, the plant can reduce inventories and increase inventory turnover: standard components often lend themselves to modular construction and mass production, and since the engineer need only review the standards to solve most of his design problems, he is freed from the catalog file and his time for creativity is increased. Often, too, the engineer is not an expert in many of the related fields in which he must work and he welcomes dependable standards in these fields.

Since so many decisions in industry and government are based on the validity and accuracy of the standards, a special responsibility falls on the men who make the choices and set the standards. Feeling this responsibility, these men have formed the Standards Engineers Society. They are dedicated to lifting the occupation to professional status. A body of knowledge is being generated through trials, errors and experiments. A code of ethics is evolving and a devotion to their work is already evident.

Standards engineering offers a challenge to any engineer. Whether he develops into a specialist or decides to broaden into a generalist he will find a full measure of technical, human and economic problems. The basic requisite for the work is an ability to apply the scientific method of problem solving. Research ability, a sense of logic, writing ability, and some general knowledge of business activities will supplement the engineer's basic mathematical and scientific ability.

Creation of company standards is usually a staff function. The standards engineer works closely with the project engineers, however, since he must provide a service to them. Only by knowing their recurring problems can the standards engineer provide useful answers. His staff position allows him the time to delve deeply into all the aspects of a design or production problem. By research and consultation with experts within the company and without, he can get the over-all picture and develop a logical answer. Often the standards engineer will run experiments and tests on processes or items to determine the significant data *before* a specific problem arises.

The steps in standardization are five: investigation, selection, publication, distribution and audit. For each problem an investigation is conducted to compile data. Then, with the project engineer, a selection is made on the basis of the data and a standard is written. The standard is categorized, numbered and published for distribution. Distribution includes seminars and conferences to explain the standard to those people it will effect, as well as to physically place the standard in the user's binder. Once the standard is distributed a dynamic audit and periodic review assures it proper use and continued usefulness.

While most standards engineers enjoy solving problems many other plant problems will lend themselves to solution

(Continued on Page 31)

"What did you say your Major is?!?"

by JENNIFER TUCK

Reprinted, with permission, from the Washington Engineer, Oct. 1959 issue.

". . . and then this blonde walked in. She must have been about 40-23-36, and her skirt was so tight you could see the dimples on her. . . ."

I have interrupted more dirty jokes, said hello to more men, and handed in more problems the last two years than most girls do in a lifetime. I have blushed so many times I am in a perpetual state of color change, like a chameleon walking across a checker board. And it's no wonder. From the time I tip-toed into my first General Engineering class, there has been a continuous sinusoidal wave of peculiar situations—some humorous to an extreme, some embarrassing to the same extreme, and many between.

The majority of you probably think that any girl who is silly enough to enter the College of Engineering deserves problems. I sympathize with your attitude. Unfortunately, some of my classmates have had to suffer in situations I created.

In a chem lab, I turned on a wrong faucet and hit an innocent fellow right square in the back with a stream of water under at least thirty pounds pressure. By the time I got the water shut off, he was sopped from his shoulder blades to his hip pockets. Was I satisfied? No. Twenty minutes later I turned on the same faucet, missed the lab instructor by about four inches, and hit the same poor fellow in the back again. He turned (I expected to be attacked with his rigstand) and gave me the sickest smile I have ever seen. At times like this, I seriously consider changing my major to Home Ec.

The closest I have actually come to changing my major, though, was after a particularly difficult day in Economics for Engineers. To sit in a classroom of a hundred and fifty men is something to which I have grown accustomed; but to sit there while the professor discusses the pros and cons of state support for illegitimate children is something completely different. He wanted to know if prostitutes would be discouraged if they had to support their own fatherless offspring. The situation got progressively worse. Some of my honorable colleagues thought this would curb their sinful tendencies; some thought it would not. Some just kept looking at me to see if I was blushing. (I was.) The professor (a fiendish character) decided the discussion was lacking in the women's viewpoint and asked me if I was considering bearing illegitimate children to get state support. Never in my life have I turned so many colors in so short a time. I should have told him that engineers are supposed to make enough money from other sources so that there is no need to use such devious means, but I was too busy trying to disappear.

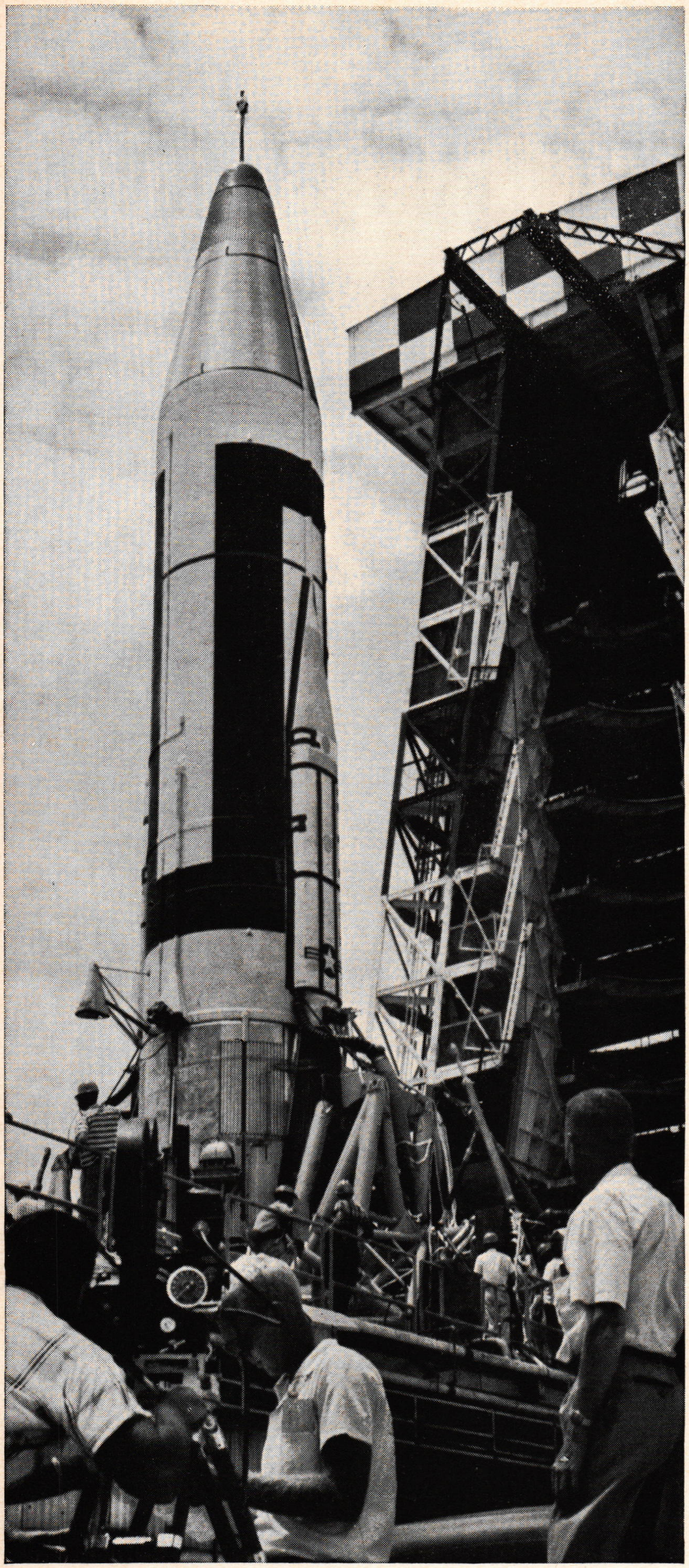
Thank heaven not all profs take such advantage of having only one girl in the class. For some of them, such a situation means they can't use much of their colorful vocabulary; for others it doesn't make the slightest difference. I have often wondered if it was difficult to teach a class of twenty-five men and one girl.

One thing about the faculty I will never forget, and that is what I call the "Professor Appeal." It happens at the beginning of every quarter in at least one class. Soon after the tardy bell has rung the prof will write the name of the course on the board, look right at me and say, "Does everyone here, belong here?" I smile in sympathy and nod my head slightly. After the initial shock, he takes my presence gallantly, as do you, the others.

Your reactions upon finding a girl huddled in a corner of what you assumed would be an all-male class, are many and varied, but a few stand out. Originally the most common and most pathetic was the "I'll ignore her and maybe she'll go away" type. The beginning of each year is abound with the "What! A girl Engineer?" reactions. They gradually fade during the following quarters.

Your reactions to actually having to work with me as a classmate are also in distinct categories. Those of you I sympathize with the most are the ones who react with "Don't ask such stupid questions." How you fellows have put up with my monumental ignorance will always be a mystery to me. When I went into G.E. 102, I didn't even know how to pronounce lathe, let alone know whether it had rotating or reciprocating motion. Deciding whether a

(Continued on Page 31)



Atlas missile, built by Convair (Astronautics) Division of General Dynamics Corporation as prime contractor.

ANOTHER WAY RCA SERVES DEFENSE THROUGH ELECTRONICS

RCA ELECTRONICS CUTS DOWN THE COUNTDOWN

To our missile experts, "is it ready" is almost as important as "how far can it go." For retaliatory power, missile crews must be able to launch a maximum number of missiles in rapid fire order.

America's intercontinental ballistic missile, the Atlas, had already proved itself for distance on a 5500-nautical-mile range. But checkout and launching took several hours. So the next step in turning the missile into an operational weapon was to make it ready for quick action. RCA was selected to build an electronic system that would radically reduce the countdown time at the Atlas Operational Bases now under construction.

Now, in a matter of *minutes*, this elaborate electronic system can determine if any part needs attention—or signals that the missile will be ready to go.

This automatic checkout equipment and launch control system for the Atlas is one more of the many ways in which RCA Electronics works to strengthen our national defense.

RADIO CORPORATION OF AMERICA

How to Build

A RESONANT FREQUENCY BATHROOM

by GUERDON TRUEBLOOD

In keeping with the "build-it-yourself" trend which is sweeping the country, the following article is presented in the hope that those hobbyists among the readers will find in it a new avenue on which to steer their creative efforts.

(Ed. note: This article is reprinted from the April 1955 issue of Mecheleciv. The editor feels it is too good to be kept from the public any longer.

Unfortunately, this article will only concern those people who like to sing in the bathroom. If you are not one of those select few who do, then I feel sorry for you; not because what I have to say will be of little interest to you, but rather that you have bypassed one of the finer things of life.

Any observant person has noted, as he sings away while bathing, that there is one note louder than the others, one note of brilliance and feeling. When you put your heart into that one frequency of sound, the whole house feels as if it were shaking with the beauty of it, and if your house is anything like the one I live in, it *is* shaking. Your imagination has nothing to do with it.

The reason for this occurrence is the simple law of resonance. As applied to this case, it may be stated that any reinforcement of sound caused by sympathetic vibrations is resonance. Only one frequency of sound, or a multiple of it, will cause the greatest reinforcement. The exact frequency depends on the volume of the room, or cavity, the gain in intensity of the sound depends on the rigidity of the walls. Other notes may seem louder in the bathroom, as compared with elsewhere, because it is a confined space and you are alone. But this is not resonance; it is art.

The first time I realized my bathroom was resonant, I felt weak inside, giddy, for with that realization had come a promise of an ecstatic future. You see, I was tired of solo work. It is adequate to a beginning bathroom artist, but it soon loses its glamour when you think of duets and accompaniment features. I tried the aria from "Faust" across the point of resonance and reeled drunkenly from the tub when I had finished the second ending. I have a high voice, unfortunately, but when I sang the high note of the aria, I heard another voice join mine to support the beauty of the thing: it was the voice of the bathroom. The sound of that one note set the bathroom to vibrating at its resonant point, one octave below my voice. It was breathtaking.

The tragic part of my discovery was learning that only one note could resonate the bathroom. Singing the same note can be pretty monotonous, if you have ever tried it. The only way to change the point of resonance was to change the volume of the bathroom cavity. I first tried placing large, airtight wooden boxes in the middle of the floor, and succeeded in raising the resonant point from D-flat to E-natural, a distance of three musical half-steps. I divided the total computed volume of all the boxes by three to determine the size of a box equivalent to one half-step, and then built three new boxes of just that volume each. I then had four different notes of resonance if I removed or added the new boxes to the bathroom cavity.

This system worked quite well until my wife put a stop to it. She said that she was sick and tired of hearing me stop in the middle of a song, splash out of the tub, open the bathroom door, throw one of the boxes into the hall, slam the door, jump into the tub and begin again on a different note. The wallpaper in the hall began to peel from the effects of the steam escaping through the door when I opened it. The door even suffered a mishap at the end of the second act of "The Pirates of Penzance." I was training myself to add or subtract a box from the room without losing a beat, and didn't quite get the door open when I threw one out. The bathroom got a new door and the boxes got the fireplace.

For weeks I wondered how to recapture the paradise I had known before, and yet have a greater range of resonance. Being an artist and not an athlete, I hoped to make the process automatic, or at least semi-automatic. One evening, I was sitting in the bathtub rendering my version of "The Desert Song," when my eyes strayed to the ceiling. The key was there; all I had to do was make the ceiling move up and down at my command. It would change the volume of the bathroom and thus its resonant

frequency, too. I would have the ultimate in artistic goals —the variable resonant frequency bathroom would be mine!

I computed the distance the ceiling would have to travel to change the frequency one half-step in pitch, picked an arbitrary point to be ceiling center pitch, and drew up the plans. The average hobbyist will have to consult a trained sound engineer for figures to suit his individual bathroom.

(A word of caution. Be discriminating in your choice of the man. Some people just wouldn't understand . . .)

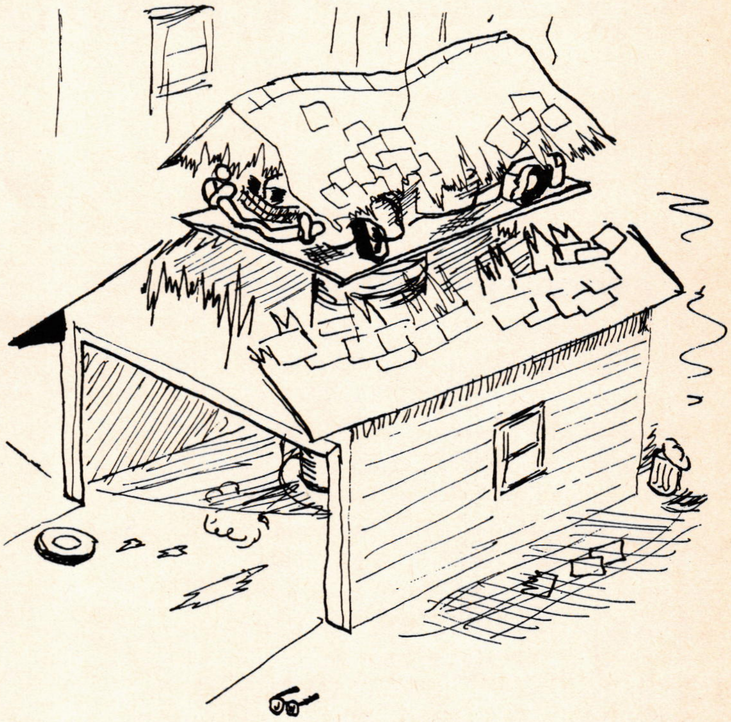
The next step is procuring a 1908 OTIS two-story, steam operated, hydraulic elevator lift mechanism. I found it to be the most acceptable of all the commercial equipments available today. Recondition the machinery and then try a test run in your garage, using the family automobile for a suitable weight. Be careful to balance the car perfectly on the lift platform and refrain from raising it too high, or you may have to buy a new garage. I was fortunate in thinking to use my neighbor's garage and it became his problem when my Stutz went through the roof. You must forgive me, but most pioneers have been known to make mistakes. When it operates satisfactorily, go on to the next step.

The machinery must have a suitable platform to rest upon and in most cases the structure of the house has to be of steel reinforced. The machinery only weighs 4750 pounds, so your stress computations do not have to be too exacting. After the platform is constructed, an aperture must be opened in the roof to allow the crane to set the machinery in place. Bolt it down securely, with the lift platform just level with the ceiling at center pitch.

The boiler must then be installed in the basement. Any one will do, really. I used an 1867 Baldwin freight locomotive boiler which has rendered comparatively trouble-free operation since the time it indulged in a minor explosion which shattered all the windows in the house and flooded the basement. The simplest way to place it in the basement is to dig a sloping roadway in the lawn, down to the level of the basement floor. After removing a few bricks from the outside wall, the boiler slips into place easily. You may find it necessary to deepen your basement somewhat and strengthen the floor, but, again, this would be an individual problem for each house involved. The steam pipes to the lift mechanism should be run inside the house, as the loss in pressure from condensation during the winter months could raise havoc with the simplest chorale.

Next, you have to make a few simple alterations in the bathroom structure. Knock out the ceiling and insert a stainless steel sleeve flush with the walls and corners. Allow the bottom of the sleeve to sit three feet below ceiling center pitch and the top continue to at least three feet above center. Then construct a piston ceiling of one-half inch sheet steel to fit perfectly into the sleeve. When first inserted, mine squeaked as it slid up and down, but a few applications of Wildroot Cream Oil quieted it down considerably.

Then attach the steel ceiling to the lift mechanism by means of copper push rods. A few lever problems might arise, but a working knowledge of integral calculus should



First, a careful test run of the machinery should be made in your garage.

be more than adequate for their solution.

The majority of the work is now done. The bathtub control is the only remaining addition. An elevator handle is installed slightly above the soap dish in the spot where you always reach for the soap when your eyes are closed. This will enable you to always find the handle, and results in a considerable yearly savings on soap. The handle is connected to the lift mechanism and your variable resonant frequency bathroom is complete.

It might be suitable here to add a few safety features. A steam release valve on the boiler is a must. I learned this the hard way. A device to stop the ceiling after it comes down so far is a good idea, too. My sister's husband plays professional basketball, and one time when they were visiting, he mistook the ceiling control for the shower valve. He only received a minor concussion, but it could have ruined his career.

Some time will pass before you can judge just where to stop the ceiling to get the proper note, but it is worth all the practice you can afford. In the beginning, it may help to determine exactly where the tones are and mark the ceiling sleeve at those points. However, it is much better to learn to play the bathroom by ear; it is more natural. I can't possibly express how much enrichment my life has received, just from the outlay of a few dollars and the utilization of a few constructive weekends.

CAMPUS NEWS

ENGINEERS' COUNCIL

The Engineers' Council devoted a good portion of its meeting last month in preparing for future events. They arranged for the Christmas Tree Lighting Monday, December 14, and, with the help of the Kappa Kappa Gamma Sorority, elegantly decorated five trees; a big one behind the University Library, one in the lower lobby of Lisner Auditorium, one on Lisner stage, one in the Davis Hodgkins House, and one in the lobby at Tompkins Hall. All the trees will be presented to orphanages in the area the Friday following the ceremonies.

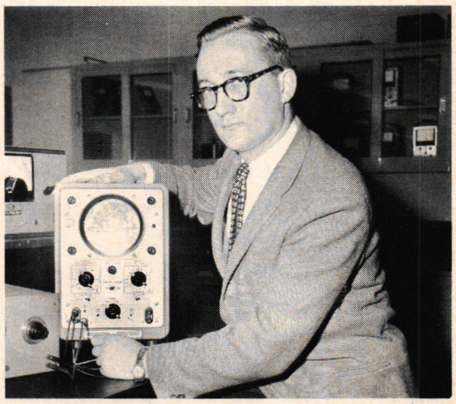
The Council also initiated a program giving the School of Engineering an Engineering Queen. The title is new and possibly misleading. The girl elected will not necessarily be an engineering student, but will be selected by engineering students only. Actually the engineering student body will not have complete freedom in their selection; the Engineering Queen will be elected from the six Mech Misses, of this school year, who are chosen by the MECHELECIV staff. This presents no problem, as the staff has proven it is quite statistically minded. The crowning of the Queen has been slated for the Engineers' Ball and Banquet (which falls on April 23, 1960, this school year), after her election on Friday, eight days before the Ball.

It is probable that the girls will appear, for a sneak preview, at the Engineers' Mixer which is being sponsored by the Council Wednesday, January 27th, between semesters. Their appearance will be but a small part of the program planned for the evening. With the forethought going into this Mixer, it promises to be one of the better ones held. Besides the entertainment, a buffet supper is planned, and all who attend will find the Mixer well worth their time.

The Tutoring Committee of Sigma Tau

The Tutoring Committee of Sigma Tau exists for the purpose of aiding students in gaining greater proficiency and understanding in courses that might cause them difficulty. Students who need help should contact the Tutoring Committee by placing a note in the Sigma Tau mail box in the Davis-Hodgkins House, 731 22nd Street. Note should contain your name, phone number and subject in which you need help. Also, it is helpful to the Committee if you indicate at what time you are available for tutoring. You may indicate your preferred time.

Tutoring Committee will find a member of Sigma Tau who is qualified to tutor you, then the Tutoring Committee will contact you. Help can be obtained in any course in the engineering curriculum. There is no charge for this service. Contact the Tutoring Committee well in advance of your exams; the members of the Sigma Tau are glad to help you, but you must still do the work.



LEON SIBUL . . . chairman of the Joint Student Branch, Institute of Radio Engineers-American Institute of Electrical Engineers, was born in Estonia. After leaving Estonia in 1944 to complete his high school education in an Estonian school in Germany, he came to the United States in 1950. Leon has long been interested in electricity and electronics, and, as a teenager, spent much of his free time reading and studying basic theories and new developments in the field. After a variety of jobs here in the states, he joined the Air Force. His knowledge and interest in electronics paid dividends . . . when time came to be assigned, Leon took a "by-pass exam" and instead of going to one of the Air Force's Technical Training Schools, he went directly to the Air Research and Development Command. San Antonio, Texas, was his first duty assignment, and there he was engaged in the design and building of small electronic circuits. Later, he worked as a radio technician in Korea with temporary duty assignments in the Phillipines and Formosa—and a little vacation time in Japan.

In January, 1957, he was released from

(Continued on Page 26)

He's an Allis-Chalmers Engineer

He has confidence born of knowing where he's going and how he's going to get there. The graduate training program at Allis-Chalmers helped him decide on a *specific* career — and he had a choice of many. He knows his future is bright because Allis-Chalmers serves the growth industries of the world . . . produces the widest range of industrial equipment. He is confident of success because he is following a successful pattern set by Allis-Chalmers management.

Here is a partial list of the unsurpassed variety of career opportunities at Allis-Chalmers:

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Crushers
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Motors
Control
Pumps
Engines
  Diesel
  Gas

Fields

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Hydraulics
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The graduate training course helps you decide on your "Very Important Position," by giving you up to two years of theoretical and practical training. This course has helped set the pattern of executive progress since 1904. For details write to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

CAMPUS NEWS

(Continued from Page 24)

active duty and immediately entered George Washington University with advanced standing in mathematics and electives. He plans to graduate in June, 1960, just 3½ years after entering GW. In Summer Sessions, Leon has studied advanced math courses. "I feel," said Leon, "that courses in advanced math give a student a deeper insight into any problem. And they are particularly important for someone who wants to study for a Master's degree."

Concerning graduate work, Leon has definite ideas. When asked about his plans for the future, he explained, "Like many of the seniors, I'm participating in the University's Placement Program. I have several possibilities in mind, but I want to look carefully at each one. One qualification a company must have is a location near a good University so that I can study for a Master's degree."

His interests are varied. During the interview, the subject of politics arose. Leon showed that he really knew what he was talking about in the field of foreign affairs. Having lived in Europe most of his life, he has a grasp of Asian and European history and geography that would put to shame many native Americans. His opinions are firm and well-based, and his arguments are *very* persuasive.

One non-political opinion he voiced was the importance of the IRE-AIEE to students studying electrical engineering. "The monthly meetings offer an opportunity to hear first-hand what is being done in industry. And," Leon explained, "even if a student feels that he can't spare two hours every month to attend a meeting, being a member of the National Branch of either organization entitles him to a copy of the proceedings of the organization, as well as transscripts of the meetings of various professional groups. These are interesting and informative—they cover developments which are not public knowledge—and they make invaluable reference material."

Leon is a member of Sigma Tau, the engineering honor fraternity, and serves as Chairman of the Tutoring Committee of Sigma Tau. This committee provides tutoring service to those students who need and request it. Being its chairman can keep a person pretty busy. "But," says Leon, "I like to keep busy if it's something that you can learn from."

DAVE ANAND

The energetic president of the ASME is Dave Anand. This young chap who graduated from our fair school in only three years was born near Lahore, India in 1938. After graduating from high school in India he came to the USA at the age of 18 years. After six months at Catholic University he saw the light and transfered to GW where he enrolled in the ME department. Dave was graduated from GW in the spring of 1959 with a Bachelor's Degree in Mechanical Engineering. At the present time Dave is working at Carrier Air Conditioning Co. as a design engineer, while attending the Graduate School at GW part time.

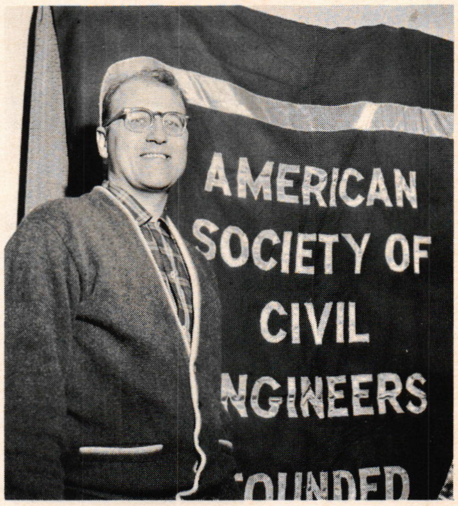
Dave is not married at the present time although he contemplates a trip to India in the near future to seek a wife.

His plans for the future are indefinite; he is undecided whether to remain in this country or to return to India for good.

As far as his education at GW is concerned he feels it has more than adequately prepared him for his job at Carrier Air Conditioning.

Dave has ambitious plans for the ASME. Under his administration the membership of the student chapter has greatly increased and he intends to increase it even farther if that is possible. He feels that by providing the ME students with interesting and enlightening programs he will entice more of the students to attend the monthly meetings.

JAMES H. CRIST



The president of the GWU chapter of the ASCE is ***Jim Crist.*** Jim was born in Washington, D. C., in 1931 and attended Washington and Lee High School in Arlington, Virginia, where he graduated. In high school he majored in what he likes to refer to as horses, poker and women. Before coming to GWU Jim spent some time going to Montgomery Jr. College.

Jim is married and is expecting his first child in March of next year.

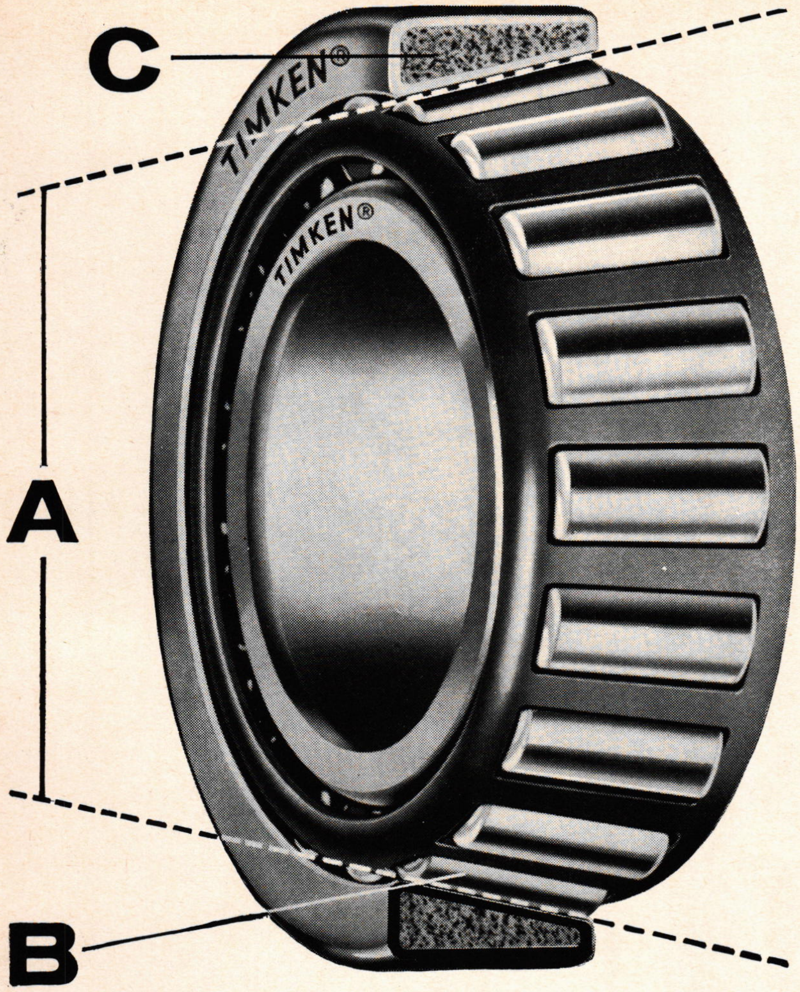
His military experience included 22 months in the Navy, 5 months of which were spent on the Cruiser Columbus cruising around the Blue Mediterranean. Jim said he liked it overseas and it was a very interesting experience.

On campus Jim is a member of ASCE, Theta Tau and last year was circulation manager of the MECHELECIV. He says if he can pass his one remaining course, EE-12, he will graduate in June of 1960. Upon graduation he would like to get a job in the general construction field. His favorite courses in school have been concrete, structures and steel.

His hobbies include horses, poker, fishing and the demands of our ever increasing population.

Sitting in class on Saturday morning recently were three night owls in tux and tails. The professor, a rather narrow-minded individual, viewed the group scornfully and commented: "I would rather commit adultery than attend class in evening clothes."

From the back of the room a voice replied, "Hell, who wouldn't?"



What is a Timken® tapered roller bearing?

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B. *Full line contact* between rollers and races gives Timken bearings *extra* load-carrying capacity. This enables a design engineer to cram maximum capacity into minimum space. And Timken bearings can be pre-loaded for accurate gear or spindle alignment.

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BETTER-NESS rolls on

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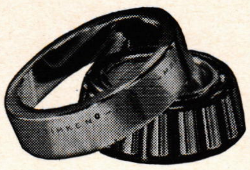

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MECH MISS . . .

Fellows, meet the University's Homecoming Queen—lovely, blue-eyed blonde Dorothy Williams. Dottie is a junior Foreign Affairs major who has packed a lot of living into her twenty years. Born in Limon, Colo., the daughter of a Marine Colonel, she has lived in China, England, Italy, Germany, and on both coasts of the U. S., and has visited eleven other foreign countries. Dottie remembers meeting the parents of last month's Mech Miss, Kay Buchanan, in Peiping ten years ago!

A pledge of Kappa Alpha Theta, she is kept busy by an amazing variety of school activities. In addition, Dottie has studied voice (she prefers the semi-classics), paints, loves to ride horseback, hunts (but she admits she could never shoot an animal), and is a pretty fair boxer (remember her Dad is a Marine).

Although she hopes that her projected teaching career may in some way further international understanding, Dottie believes her primary mission in life is "to stand behind my man." We say that with this kind of backing, how could any man fail?

SEN. HUMPHREY *(Continued from Page 7)*

cent—and that a major reason for this inefficiency stems from the lack of effective indexing to coordinate and control scientific information. We are wasting valuable research time in duplicating work already completed or underway. Our stockpile of knowledge has become an embarrassment of riches.

I have proposed the establishment within the Federal government of a Department of Science and Technology to put more "horsepower" behind governmental scientific activities, and to develop a framework for better coordination of non-governmental, as well as governmental scientific and technical information.

Such a new department would coordinate the scientific activities of the National Science Foundation, the Atomic Energy Commission, the National Aeronautics and Space Administration, the National Bureau of Standards, the Smithsonian Institution, indeed, the more than 40 government bureaus, divisions, or agencies currently engaged in research activities.

Following one of the major objectives of the original Department of Science proposal in the 85th Congress, the National Science Foundation was charged by Congress recently with the responsibility of making scientific information more broadly available by indexing, abstracting, translating and disseminating such information. There has been new activity by private agencies, universities and professional societies to index and exploit the world's scientific and technical literature. Important work in this field is going on right here at George Washington University. G. W. U. is conducting experiments in using electronic computers to prepare scientific indexes with grants from the National Science Foundation.

This kind of research in electronic indexing may well provide the most fruitful method of organizing and spreading scientific information. Successful indexing of research and information will enable us to exploit our knowledge instead of wasting time and manpower in experiments or investigations made already. Thus, our engineers and our scientists will be able to apply existing knowledge more efficiently and they will be able to push out the frontiers of knowledge more rapidly.

Every professional engineer would agree with me, I feel sure, that it is not enough to compete with the Soviet system in terms of material goods production alone. Our engineers and scientists share with all our citizens the responsibility for maintaining a society which guards the liberty and dignity of all men and women. So many of our professional men and women from engineering and the sciences, you see, move from purely technological and research fields into decision-making positions affecting broad national policy. For this reason, it is vital that while training and education of students in the sciences and engineering must be stepped up and intensified, we should never lose sight of the overriding importance of their understanding the great political, social and economic forces at work in the world—forces which vie with the most spectacular developments in science and technology in molding the world of the future, the world of our children.

Placement Interview Schedule

Visiting Date	Company	Interviewing
5 Jan.	General Motors Corp. Detroit, Michigan & US	ME, EE, Chem. Physics, Bus Adm & Liberal Arts
11 Jan.	National Security Agency Fort Meade, Maryland	Liberal Arts Others
11 Jan.	Chas. Pfizer & Co., Inc. USA and, overseas	EE, ME, CE, IE BSE, MEA, Chem Pharmacists, & Liberal Arts Business Adm.
12 Jan.	National Security Agency Fort Meade, Maryland	EE, ME, Math Physics
12 Jan.	TEXACO, Inc. USA	EE, CE, ME, IE Bus Adm w/Engr Background
12 Jan.	Factory Mutual Engr Division Norwood, Mass.	ME, EE, Chem E CE, IE
13 Jan.	Tennessee Valley Auth. Knoxville, Tenn.	CE, EE ME Economists
13 Jan.	IBM US	ME, EE, Physics Math, Accounting Economics, Bus Adm Liberal Arts
14 Jan.	Chrysler Corp. USA	All Engineers Math, Physics Bus Adm, Accounting Liberal Arts
14 Jan.	Stromberg-Carlson Co. Rochester, N. Y.	EE, Physics, Math EE
14 Jan.	Parke, Davis & Co. Detroit, Michigan and US	Chem E, ME Accountants
19 Jan.	West Virginia Pulp & Paper Company Covington, W. Va.	CE, EE, ME, Chem BSE w/options in Bus Adm & Chem

STANDARDS *(Continued from Page 18)*

through standardization. The standardization program at Litton Industries Maryland Division is a good example of this. The purpose of the program is to reduce the cost of designing and manufacturing electronic products. After research through pertinent military, government and industry standards, those standards most useful to the company are selected, refined when necessary, and combined with original Litton standards into six useful books. The application of standards engineering to reducing costs by solving recurring company problems, reducing options, and by improving communications is evident in the books.

Beginning with an idea, the project engineer uses the Design Guide book to review the general design considerations, tolerances, comparative costs, military requirements, and other parameters of the process or design he wishes to use.

When the feasability of the design is thus established, the engineer turns to the Design Standards and Standard Parts book for specific values and components. These are books that actually do the most to free the engineer from searching the catalog files for specific design data.

The draftsman prepares the project engineer's design for communication using the accepted drafting conventions and practices contained in the Drafting Room Manual.

By using the Print Interpretation Manual shopmen and inspectors can accurately interpret the drawings and can tell what is required by the project engineer.

The Manufacturing Standards book provides the shopmen with the data needed to produce a finished product acceptable to the engineer and to the customer.

These six books form the core of the program at Litton: other companies have books or documents which may have different titles but which perform the same vital standardization functions. Thus, by reducing options and providing readily accessable answers to repetitious problems, standards engineering allows the engineer and many others in the plant more time for creative effort.

CONFESSIONS *(Continued from Page 20)*

bolt was screwed on a nut or a nut was screwed on a bolt was a serious task indeed.

Of course, wherever there are guys, some are the "Let's step into a dark corner" type. These fast operators were quite common since the preponderant number of you used to think that I am in the College of Engineering because the ratio of men to women is about a hundred to one. Even after two years, some of you maintain I'm here to get a Mrs. rather than a B.S. in Ceramic Engineering.

The last reaction I commonly see is the "I suppose I'll have to put up with her" type (the patient martyr); kind, gentle, and politely exasperated.

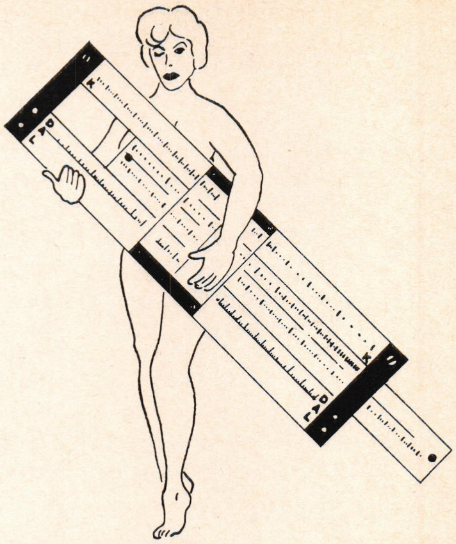
Seriously, I didn't realize when I came here that most men could be so sweet and patient. I sincerely hope that having a girl in class hasn't created any problems for you fellows besides your having to learn how to tuck your shirt in without unzipping your pants. After all, that ability may be valuable some day.

When I graduate, I will be the proud possessor of a peculiar education. Not "just" engineering; but rather how to keep up with a long-legged man moving in the traditional (and fantastic) Lower Campus Stride; how not to hear a violent condemnation of everything from the seagulls to a Math test, if it wasn't intended for me to hear; how to climb three flights of stairs in Physics Hall and not collapse when I reach the top; how to sit on those miserable stools in Miller and More Halls wearing a tight skirt and still be decent; and maybe even how to sleep with my head propped on my hand, so that from a distance I look like I am still awake, intently listening to a lecture.

If I continue to learn the kind of things I've learned in the last two years, mine will be a peculiar education—but one that I wouldn't trade for any other.

SLIPSTICK

SLAPSTICK



Oh, the amorous desires of the camel
Are stronger than anyone thinks.
One night in a seizure of passion
He tried to make love to the Sphinx.
Now the Sphinx is made out of sandstone
And rocks that outcrop near the Nile,
Which accounts for the hump of the
camel
And the Sphinx' inscrutable smile.

Coop Engr.

* * *

The locale was a nudist camp. The boy and girl were strolling through the woods. Shyly his words reached her blushing ears:

"Don't look now but I think I'm falling in love with you."

* * *

"Why don't you smile?" the teacher asked young John.

"I didn't have no breakfast," young Johnny replied.

"You poor dear," said the teacher: "But to return to our lesson, Johnny, where is the Polish border?"

"In bed with Mama—that's why I didn't get no breakfast."

* * *

An engineering professor was lecturing his 8:00 class on the virtue of being wide awake. "I've found that the best way to start a day is to exercise for five minutes after arising, breathe deeply, and finish with a cold shower. Then I feel rosy all over."

Just then a sleepy voice was heard to mutter from the back of the room, "Tell us more about Rosie."

* * *

She: "There are lots of couples who don't pet in parked cars."

He: "Yeah, the woods are full of them."

An old lady was sitting in her rocking chair knitting, her Persian cat reclining at her feet.

Suddenly a fairy appeared and asked the old lady if there was anything she wished. "Yes," was the reply. "I would like to be a beautiful young woman again."

The fairy waved her wand and there she stood; a lovely girl of twenty! "Now," asked the fairy, "is there any other wish you would like granted?"

"Oh, yes, I would like a handsome young man."

Turning to the cat, the fairy waved her wand. In its place rose a fine looking youth. He looked at the girl and sighed, "Now, aren't you sorry you took me to the vet?"

* * *

A recent survey of the commercial airplanes has turned up an astonishing fact. Ninety-five percent of the newly wedded couples fly United.

* * *

A bishop was sitting at a box in an opera house where collegiate commencement exercises were being held. The dresses of the ladies were very décolleté. After looking around with an opera glass, one of the ladies exclaimed, "Honestly, Bishop, did you ever see anything like it in your life?"

"Never," gravely replied the bishop. "Never, Madam, since I was weaned."

* * *

Little Boy: "Boo!"

Little Girl: "Don't do that, you'll scare the pants off me."

Little Boy: "Boo, boo, boo, boo!"

There was a farm girl who returned from the university after one semester. Her father met her at the station and they drove home together on the family wagon. As they traveled along, she snuggled up to Papa and confessed: "I ain't as pure as I used to be, Papa. I ain't even kept my chastity."

Her father's face fell, the horses neighed and there was a prolonged silence. Finally the father turned to the wayward daughter and said, "After all your Ma and I have done fur yuh. Scrimp an' save to send you through college. Work our fingers to the bone, and still you say ain't!"

* * *

Said the old maid to the burglar: "Sure I have money. Don't just stand there. Frisk me."

* * *

It was at the cinema, and the feature was one of those steam-heated affairs with a sultry heroine looking hungrily at a handsome hero. After some minor plot preliminaries, they went into a terrific clinch. For fully five minutes they remained wrapped up in each other, lip to lip and mush to mush. Suddenly a small childish voice piped up from the audience: "Mommy, is now when he puts the pollen in her?"

One of a series*

Interview with General Electric's Charles F. Savage Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas—meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration. This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.*

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